Stability and Bias of Yield Evaluations for Holstein Bulls in Artificial Insemination Service

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ABSTRACT

Holstein bull predicted transmitting abilities (PTA) for milk, fat, and protein yields were compared for January 1995 and May 2000, the beginning and end of the 1995 genetic base definition. Overall, PTA for the 14,012 artificial insemination (AI) bulls born in 1980 or later were stable for mean but varied slightly more than expected based on increase in data. As expected, changes were larger for bulls with lower initial reliability (accuracy) and greater increases in reliability over the 5.3 yr. For the 540 bulls in active AI service during 1995, mean PTA changes were near 0 (-8 kg for milk, -1.3 kg for fat, and -0.5 kg for protein). Bulls in the top decile for PTA milk, fat, and protein declined 47, 2.2, and 2.2 kg, respectively, but that bias was not evident for bulls that had been progeny tested by major AI organizations (sampling code S). The standard deviation for change in PTA milk for top decile bulls was 191 kg; expected standard deviation was 140 kg. Consideration of only bulls with a sampling code of S removed the excess variation, which indicates that bulls from other sampling programs are the source of bias and lack of stability. Bulls with a sampling code other than S appeared to have an initial PTA that was biased, largely because of an inflated estimate of daughter performance. The hypothesis that inflated means of parent PTA produce inflated early PTA of bulls was not corroborated. Stability of the genetic base and unbiasedness of PTA was demonstrated for bulls with a sampling code of S, but concern continues for bulls with other sampling codes. Because much of the bias in PTA for those bulls is expected to be the result of preferential management of early daughters, improvement of the evaluation system to remove that bias will be difficult.
(**Key words:** genetic evaluation, bias, sampling, stability)

Abbreviation key: DYD = daughter yield deviation, **PA** = mean PTA of parents (parent average), **REL** = reliability of PTA.

INTRODUCTION

Stability of genetic evaluations is always of interest to breeders and dairy producers. Buyers of semen or cattle are particularly disappointed when an evaluation declines shortly after purchase. However, the addition of records on an individual or relatives will always bring about change, in most cases toward a more accurate evaluation. To have an evaluation not change, the evaluation would need to be made permanent after the first test day of a cow or after a bull has 10 daughters with records. With a heritability of <1.0, estimates of genetic merit should and will change when observations are added or modified. The genetic estimate for an individual animal may either increase or decrease with added data, but if the mean of evaluations for any defined group of animals changes in either direction consistently, a bias in evaluations is indicated for those animals. Whenever feasible, sources of bias should be identified and eliminated in the evaluation system or at least accounted for in the the interpretation of results.

Change in evaluations is related directly to the increase in amount of information, which is expressed as reliability of PTA (**REL)**. Thus, subsequent change in bull evaluations can be reduced by obtaining initial progeny tests that are more extensive. Subsequent change should be random for direction. If a group of bulls characterized in any way (region, owner, age, REL) tends to increase or to decrease in PTA with added data and that change is significant, the evaluations of those bulls are considered to be biased. Powell and Norman (1981) reported on changes in evaluations for Holstein bulls under the modified contemporary comparison evaluation system. Predicted differences increased with repeatability up to 70 to 79% and then decreased. Absolute changes increased with larger increases in repeatability, and variability of differences generally agreed with expected changes. Mean difference between daughter yield deviation (**DYD**) and mean PTA of parents [parent average (**PA**)] for groups of bulls was used as a measure of bias in animal model evaluations (Powell et al., 1994). Holstein bulls brought into AI service but not sampled in AI were biased upward by 46 kg of milk (DYD - PA) relative to bulls in AI progeny-test programs. Cassell et al. (1992) noted that PTA of bulls that were sampled outside AI declined considerably more than PTA of contemporary AI-sampled bulls. However, the eventual estimate of merit averaged about the same for both groups; i.e., bulls from either sampling situation and marketed through AI were of comparable merit for the same birth year.

The objective of this study was to evaluate the stability of genetic evaluations of Holstein bulls and to determine whether bias exists according to REL, PTA, pedigree merit, or type of sampling.

MATERIALS AND METHODS

January 1995 genetic evaluations of yield traits (milk, fat, and protein) for 14,012 Holstein bulls with an AI organization as controller and born during 1980 or later were the initial data. Focus was placed on 540 bulls in active AI service at that time. Those evaluations were compared with corresponding May 2000 evaluations. The January 1995 and May 2000 evaluations were the first and last evaluations, respectively, under the 1995 genetic base (mean evaluation of cows born during 1990 was set to 0). Thus, the data provided the maximum time range within a single base interval. Because of the delay from February to August in implementation of the 2000 genetic base, the period covered was 5.3 instead of 5 yr. During that interval, evaluation procedures were revised: foreign dam information was included, owner-sampler records were included, heritability was increased, and best prediction was used to estimate lactation yield from test-day data when available. Some of those revisions impacted the appropriateness of expected changes because continuity of methodology is assumed for the theoretical calculations. However, those procedural differences over time were not expected to degrade examination of bias appreciably.

For January 1995 evaluations, Canadian yield evaluations were combined with US data for Canadian bulls. That process was discontinued for February 1997 evaluations when Interbull evaluations were accepted for Canadian as well as other foreign bulls. Therefore, bulls with combined data were excluded to allow for the assumption that all early data were included in later data, which was accomplished by the requirement that the percentage of US daughters in 1995 evaluations was 100.

Sampling status was addressed through sampling organization and sampling code. Organizations were classified as traditional [National Association of Animal Breeders (Columbia, MO) organization code of <30] or other. The other organizations can be characterized as smaller organizations that often have less rigorous sampling schemes. Sampling codes during 1995 were S, M, and O (Sattler, 1990). Bulls that were reported to have had semen distributed to a minimum of 40 herds were coded as S if sampled by an organization that not only owned or leased the bull but also processed and marketed the semen. Bulls that met only the 40-herd requirement were coded as M. The distinction between S and M codes was to differentiate between bulls sampled by full-service organizations that did not have self-interest in which particular bull had a successful sampling result and other bulls for which there could be a vested interest in the result for a particular bull. However, because the assignment of M and S codes was somewhat controversial and difficult to administer, the distinction between M and S bulls was eliminated during February 1999 (Holstein Association USA, 2000), and M bulls were recoded as S bulls. The O bulls were other bulls that had not been reported as having been sampled in at least 40 herds by 3 yr of age.

Primary interest was in PTA changes between January 1995 and May 2000. Essentially, those changes resulted from changes in the components of PTA: PA and DYD. Subsets of bulls were defined by sampling status (organization and code), 1995 REL, REL increase, and 1995 PTA. Changes in evaluation components were examined overall and for those data subsets.

RESULTS AND DISCUSSION

As expected, PTA for bulls in the complete data set changed little on average (Table 1) because most bulls added little or no data; however, the stability of the genetic base was reassuring. Bulls that had an REL increase of <5% included bulls with no REL change. A total of 379 bulls had the same REL for both 1995 and 2000 evaluations, and their SD of PTA change was the same as for all 7677 bulls with REL increases of <5%. Theoretically, evaluations for bulls that add no information (from daughters or other relatives) should not change. However, theory does not consider that REL change might be masked by rounding or that, even with the same REL, data from which that REL was calculated may have changed. Corrections of yield data can lead to different PTA from the same amount of data, or pedigree corrections can result in replacement of daughters (i.e., elimination of some, then addition of others). Nonzero SD of change for cases in which REL is unchanged provides a basis for other SD that are larger than expected.

Table 1. Means and SD for PTA changes between January 1995 and May 2000 for AI Holstein bulls that were born during 1980 or later by increase in reliability (**REL**) and

yield trait.

REL increase (%)	Bulls (no.)	Milk (kg)		Fat (kg)		Protein (kg)	
		Mean	SD	Mean	SD	Mean	SD
All	14,012	-5	89	-0.3	3.3	-0.2	2.6
<5	7677	-2	54	-0.1	2.0	-0.1	1.6
5 through 9	4434	-5	94	-0.2	3.4	-0.1	2.8
10 through 14	828	-13	138	-0.5	5.1	-0.3	4.1
15 through 19	518	-14	159	-1.0	6.2	-0.4	4.7
20 or greater	555	-19	187	-1.8	7.4	-0.7	5.5

Genetic evaluations for milk, fat, and protein tended to decline slightly more for larger REL increases (correlations of -0.04 to -0.09 and highly significant ($P < 0.001$). If the cause of this decline is unknown, the decline not surprisingely would become larger as the amount of additional information increased. The corresponding SD increases for larger REL increases are more noticeable. Those increases are in general agreement with expected values (not shown), although often about 10% higher, perhaps because of the prior explanations for theoretical differences and because of minor changes in methodology. Expected SD of change was computed as the square root of the REL change times the estimated sire SD provided by Interbull (International Bull Evaluation Service, 2000). Those sire SD were 338 kg for milk, 12.30 kg for fat, and 9.35 kg for protein.

Mean changes in PTA milk, fat, and protein appeared to be essentially independent of initial REL (Table 2), but correlations for bull data of -0.03 to -0.05 were highly significant ($P < 0.01$), probably a reflection of the large number of bulls. The SD of change decreased with initial REL as expected because of the smaller opportunity for large REL increases with higher initial REL. An effective way to reduce the amount of future change in an evaluation is to obtain a high initial REL, which largely is produced by having progeny-test daughters in a large number of herds.

Table 2. Means and SD for PTA changes between January 1995 and May 2000 for AI Holstein bulls that were born during 1980 or later by reliability (REL) during January 1995 and yield trait.

January 1995 REL (%)	Bulls (no.)	Mean REL increase (%)	Milk (kg)		Fat (kg)		Protein (kg)	
			Mean	SD	Mean	SD	Mean	SD
All	14,012	6.0	-5	89	-0.3	3.3	-0.2	2.6

<70	2630	10.6	1	119	-0.2	4.6	0.0	3.6
70 through 79	4372	6.5	-6	94	-0.3	3.4	-0.2	2.8
80 through 89	5752	4.5	-4	72	-0.3	2.7	-0.2	2.1
90 or greater	1258	1.6	-14	59	-0.5	2.2	-0.3	1.7

Means and SD changes for only the 540 Holstein bulls in active AI service during January 1995 are in Table 3 by REL increase. As for all bulls, mean PTA changes for the 5.3-yr period were near 0 for active bulls, but SD of those changes were about three times as large as reported for all bulls. The increased variation likely resulted from the addition of many more daughters by active AI bulls than by all AI bulls that were born since 1980. Mean number of daughters increased from 200 to 361 for all AI bulls and from 717 to 3602 for active AI bulls. Mean REL increase for active AI bulls was 14.3% compared with only 6.0% for all AI bulls. Variation for a given REL change was similar for comparable groups in Tables 1 and 3. Correlations of bull changes in REL and PTA milk, fat, and protein were significant ($P < 0.05$) at -0.09 to -0.17, but a pattern of important differences is not apparent in Table 3.

Table 3. Means and SD for PTA changes between January 1995 and May 2000 for Holstein bulls that were in active AI service during January 1995 by increase in reliability (REL) and yield trait.

REL increase (%)	Bulls (no.)	Milk (kg)		Fat (kg)		Protein (kg)	
		Mean	SD	Mean	SD	Mean	SD
All	540	-8	144	-1.3	5.4	-0.5	4.1
<5	70	-13	87	-0.5	3.0	-0.4	2.4
5 through 9	61	19	102	0.3	3.2	0.7	2.7
10 through 14	109	-11	131	-1.0	4.8	-0.7	3.8
15 through 19	177	1	149	-1.2	5.6	-0.4	4.0
20 or greater	123	-28	184	-3.0	6.8	-1.1	5.4

Active AI bulls with higher 1995 REL tended to retain their PTA at that time (as indicated by mean and SD of change) more than did bulls with lower REL (Table 4). Correlations between 1995 REL and PTA change were 0.10 ($P < 0.05$) for milk, 0.14 ($P < 0.01$) for fat, and 0.12 ($P < 0.01$) for protein, which illustrates the decline for bulls with lower initial REL. Active AI bulls had a higher SD of PTA change than did all bulls, probably because of more added data.

Table 4. Means and SD for PTA changes between January 1995 and May 2000 for Holstein bulls that were in active AI service during January 1995 by reliability (**REL**) during January 1995 and yield trait.

January 1995 REL (%)	Bulls (no.)	Mean REL increase (%)	Milk (kg)		Fat (kg)		Protein (kg)	
			Mean	SD	Mean	SD	Mean	SD
All	540	14.3	-8	144	-1.3	5.4	-0.5	4.1
<70	40	24.4	-56	156	-2.1	6.2	-1.4	4.7
70 through 79	176	18.9	-18	161	-2.2	6.2	-0.9	4.6
80 through 89	227	14.0	2	143	-0.9	5.1	-0.3	4.0
90 or greater	97	2.7	9	94	-0.2	3.2	0.3	2.5

Correlations of PTA change, and initial PTA ranged from -0.05 (not significant) for milk to -0.16 ($P < 0.001$) for protein. Coefficients for regression of PTA change on initial PTA were -0.038 for milk, –0.066 for fat , and -0.110 for protein. Although the regression coefficients for yield components were significant ($P < 0.01$ for fat and $P < 0.001$ for protein), the practical importance is not great. On average, bulls that differed by 300 kg for PTA milk, 10 kg for PTA fat, and 10 kg for PTA protein during January 1995 would be expected to differ by only 289, 9, and 9 kg, respectively, during May 2000.

Table 5 shows means and SD for PTA changes between January 1995 and May 2000 by decile during January 1995. The top 30% of bulls increased the most in REL, and the bottom 20% had the least increase, which indicated differential usage of the better bulls. The bulls with the highest PTA tended to decline the most. The top decile bulls for milk had significantly ($P < 0.05$) larger PTA declines than did the other 90% of bulls, but PTA for the top 20% did not decline significantly more than for the rest of the bulls. For fat, PTA only for the top half of the bulls declined significantly more ($P < 0.05$) than for the rest. For protein, PTA for top bulls declined significantly more (at least $P < 0.05$) than for bulls with lower PTA through the top 7 deciles. If initial PTA is equally too high for bulls in all deciles, then bull that add the most new, unbiased data (i.e., those with increased usage) would be expected to have the largest declines in PTA.

Table 5. Means and SD for PTA changes between January 1995 and May 2000 for Holstein bulls that were in active AI service during January 1995 by PTA decile during January 1995 and yield trait.

PTA decile	Mean REL increase (%)	Milk (kg)		Fat (kg)		Protein (kg)	
		Mean	SD	Mean	SD	Mean	SD
Top	17.1	-	191	-2.2	8.4	-2.2	5.9

		47					
2	16.5	-15	131	-1.8	4.6	-0.5	3.6
3	16.3	24	136	-0.7	5.5	-0.7	3.6
4	13.9	-7	148	-2.7	5.2	-1.3	4.2
5	13.9	8	125	-1.6	5.8	-0.3	4.1
6	14.2	0	152	-0.9	4.9	-0.6	3.9
7	14.2	-19	140	-1.4	4.5	-0.1	4.1
8	14.2	-28	124	-0.3	3.7	0.7	3.3
9	12.2	6	126	-1.2	4.6	0.2	3.4
Bottom	10.8	1	151	-0.2	4.9	-0.1	3.7

The SD for PTA changes showed little trend, except for the top decile for which SD were 25 to 55% higher than the highest SD for any other decile. The REL increase was highest for the higher decile bulls but not enough to explain the relatively high SD. For milk, the square root of the REL change times the sire SD of 338 kg results in an expected SD of PTA change of 140 kg. The bottom decile bulls were also much more variable for PTA change than expected, although the mean changes for those bulls were closest to 0 among all deciles.

Table 6 shows means and SD for PTA changes between January 1995 and May 2000 by decile during January 1995 for the 400 active AI Holstein bulls with a sampling code of S. The PTA for top bulls did not significantly decline for any of the three yield traits. The SD tended to be smaller than the SD for all active AI bulls, especially for the extreme deciles. Thus, bulls with sampling codes of M and O appeared to be the cause of the decline between initial and later PTA for all active AI bulls.

Table 6. Means and SD for PTA changes between January 1995 and May 2000 for Holstein bulls that were in active AI service during January 1995 with a sampling code of S[1] by PTA decile during January 1995 and yield trait.

PTA decile	Mean REL increase (%)	Milk (kg)		Fat (kg)		Protein (kg)	
		Mean	SD	Mean	SD	Mean	SD
Top	16.5	-6	140	-0.8	6.1	-1.3	4.5
2	16.4	-8	129	-1.5	4.5	-0.5	3.7
3	14.8	18	129	-1.8	4.8	-0.7	3.5

4	14.7	-8	131	-1.5	5.6	-1.1	4.2
5	13.4	3	135	-0.4	6.0	0.1	4.2
6	13.1	26	157	-1.6	4.6	0.1	3.7
7	14.0	-22	129	-1.0	4.5	-0.5	4.4
8	14.1	-20	135	-0.3	3.9	-0.1	3.2
9	14.4	3	129	-0.7	4.8	0.8	3.3
Bottom	9.0	29	129	0.3	5.0	0.4	4.0

[1]Sampled in at least 40 herds by a full-service AI organiztion.

Misidentification of sires of cows tends to reduce variability of bull genetic evaluations (Banos et al., in press). This reduced variability results in fewer extreme evaluations and more evaluations closer to the mean, and the impact would be greater for bulls with limited daughter information. As information from more daughters becomes available, the influence of a misidentified daughter lessens, and the more accurate evaluations would be expected to have increased variability and be less conservative for extreme deciles. Although the top decile was the most variable (largest SD) regardless of yield trait (Tables 5 and 6), the SD of PTA changes for the bottom decile generally was similar to SD for deciles 2 through 9. The lack of pattern across deciles suggests that the impact of misidentification of sires may not be sufficient to be apparent relative to other factors even though such misdentification results in more variability of PTA changes.

Means and SD for PTA changes between January 1995 and May 2000 also were calculated by PA decile (not shown), but no pattern in PTA change was found for either all active AI bulls or only those with a sampling code of S. For the three yield traits and two bull groups, the only significant ($P < 0.05$) correlation between PTA change and PA was -0.10 for fat evaluations of bulls with a sampling code of S.

Correlations between January 1995 PTA and PTA change between January 1995 and May 2000 are in Table 7 for all active AI bulls and a subset of those bulls that were born during 1988 or after. The younger bulls would have had only progeny-test daughters with records in the January 1995 data. All correlations were negative. For all active bulls, the largest negative correlations were for bulls with a sampling code of O, whereas bulls with sampling codes of S and M had smaller and more similar correlations. When bulls were restricted to the 306 that were born during 1988 or later, correlations were smallest for S bulls, intermediate for M bulls, and largest and significant ($P < 0.05$) for O bulls. The significant ($P < 0.01$) negative correlation between initial protein PTA and PTA change for S bulls is of concern, although the corresponding value for younger AI bulls was not significant; coefficients for regression of change in PTA protein on initial PTA were -0.10 for all S bulls and -0.08 for younger S bulls.

Table 7. Correlations between PTA from January 1995 and PTA change between January 1995 and May 2000 for Holstein bulls that were in active AI service during January 1995 and a subset of those bulls that were born during 1988 or later by sampling code of bull and yield trait.

Dataset	Sampling code[1]	Bulls (no.)	Milk	Fat	Protein
Active AI bulls	All	540	-0.05	-0.11*	-0.16***
	S	400	-0.04	-0.08	-0.15**
	M	69	-0.01	-0.10	-0.09
	O	71	-0.19	-0.26*	-0.32**
Active AI bulls that were born during 1988 or later	All	306	-0.10	-0.11	-0.15**
	S	228	-0.04	-0.04	-0.09
	M	43	-0.15	-0.25	-0.22
	O	35	-0.36*	-0.34*	-0.37*

[1]S = Sampled in at least 40 herds by a full-service AI organization, M = sampled in at least 40 herds by other AI organizations, and O = other bulls that were not reported as sampled in at least 40 herds by 3 yr of age.
*$P < 0.05$.
**$P < 0.01$.
***$P < 0.001$.

A common assumption is that cows with the highest PTA are overevaluated. If that assumption were true, PTA of sons of those cows would also be overevaluated, a bias that would diminish with the accumulation of daughter data. Concern also has been expressed about possible bias in initial DYD, particularly for bulls that are sampled outside major AI organizations (i.e., syndicates or individual owners). Correlations between January 1995 PA and PA change ranged from -0.18 to -0.31 ($P < 0.001$); correlations between 1995 DYD and DYD change ranged from -0.30 to -0.42 ($P < 0.001$), which shows that higher PA and DYD tended to decline. Because DYD is an unregressed value and active AI bulls are selected, a decline in DYD was expected. Coefficients for regression of change on initial value ranged from -0.05 to -0.08 for PA and from -0.18 to -0.28 for DYD.

To examine the relationship between 1995 pedigree or progeny estimates and PTA change, models were fit so that PTA change for a trait was predicted by 1995 PA and DYD. Partial regression coefficients are in Table 8 for all active AI bulls and younger AI bulls. All of the significant ($P < 0.05$ or less) regression coefficients were negative, and most were for bulls with a sampling code of O. The initial DYD for those bulls were too high. Among sampling code groups, the only other regressions with significant ($P < 0.05$) coefficients were for S bulls for protein DYD (all active AI bulls) and fat PA (younger AI bulls).

Table 8. Partial coefficients for multiple regression of PTA change between January 1995 and May 2000 on mean parent PTA (**PA**) and daughter yield deviation (**DYD**) for Holstein bulls

that were in active AI service during January 1995 and a subset of those bulls that were born during 1988 or later by sampling code of bull and yield trait.

Data set	Sampling code[1]	Milk		Fat		Protein	
		PA	DYD	PA	DYD	PA	DYD
Active AI bulls	All	0.03	-0.05	-0.01	-0.05	0.00	-0.08**
	S	0.03	-0.04	-0.06	-0.01	-0.03	-0.06*
	M	-0.04	-0.01	0.05	-0.09	0.02	-0.08
	O	0.12	-0.19*	0.10	-0.26**	0.04	-0.20*
Active AI bulls that were born during 1988 or later	All	0.06	-0.10*	-0.09	-0.03	-0.04	-0.08*
	S	0.01	-0.04	-0.15*	0.04	-0.10	-0.03
	M	0.12	-0.18	-0.09	-0.08	0.05	-0.17
	O	0.23	-0.38*	0.24	-0.38*	0.07	-0.23

[1]S = Sampled in at least 40 herds by a full-service AI organization, M = sampled in at least 40 herds by other AI organizations, and O = other bulls that were not reported as sampled in at least 40 herds by 3 yr of age.
*$P < 0.05$.
**$P < 0.01$.

Evaluations of bulls that were sampled by traditional AI organizations or that had a sampling code of S were essentially unchanged on average over the 5.3 yr (Table 9). In contrast, bulls that were sampled through other organizations or that had sampling codes of M or O declined on average and had more variable PTA change. Some of the higher variability of PTA change for M and O bulls can be attributed to lower initial REL (fewer progeny-test daughters), which results in larger increases in later REL. Mean daughters per herd during 1995, an indicator of sampling practice, was unrelated to PTA change, even for younger AI bulls for which the earlier evaluation was based only on records of progeny-test daughters.

Table 9. Means and SD of PTA changes between January 1995 and May 2000 for Holstein bulls that were in active AI service during January 1995 by AI organizational status, sampling code of bull, and yield trait.

	Bulls	Mean reliability increase	Milk (kg)	Fat (kg)	Protein (kg)

Sampling status	(no.)	(%)	Mean	SD	Mean	SD	Mean	SD
Organization[1]								
Traditional	401	14.1	2	135	-1.0	5.1	-0.3	3.9
Other	139	15.1	-35	164	-2.3	6.0	-1.2	4.4
Code[2]								
S	400	14.0	2	134	-0.9	5.0	-0.2	3.9
M	69	14.3	-40	152	-2.3	5.0	-1.2	4.0
O	71	16.1	-28	179	-2.4	7.1	-1.2	5.0

[1]Traditional = National Association of Animal Breeders (Columbia, MO) AI organizational code of <30; other = code of 30 or greater.

[2]S = Sampled in at least 40 herds by a full-service AI organization, M = sampled in at least 40 herds by other AI organizations, and O = other bulls that were not reported as sampled in at least 40 herds by 3 yr of age.

Differences in mean PTA changes according to sampling organization and code were more extreme for younger AI bulls (Table 10). For bulls that were sampled by nontraditional AI organizations or that had a sampling code of O, PTA declines were larger for young AI bulls than for all active AI bulls; corresponding changes for M and S bulls were small. Those results support that initial evaluations of bulls that are sampled outside traditional organizations or with a sampling code of O are positively biased and that the bias diminishes with data from second-crop daughters.

Table 10. Means and SD of PTA changes between January 1995 and May 2000 for Holstein bulls that were in active AI service during January 1995 and born during 1988 or later by AI organizational status, sampling code of bull, and yield trait.

		Mean reliability increase	Milk (kg)		Fat (kg)		Protein (kg)	
Sampling status	Bulls (no.)	(%)	Mean	SD	Mean	SD	Mean	SD
Organization[1]								
Traditional	228	17.4	1	143	-1.1	5.5	-0.3	4.2
Other	78	16.8	-50	180	-2.6	6.8	-1.6	4.9
Code[2]								
S	228	17.2	0	142	-1.1	5.5	-0.3	4.1
M	43	15.9	-49	154	-2.2	4.8	-1.4	3.9
O	35	19.0	-45	215	-3.0	8.7	-1.8	6.1

[1]Traditional = National Association of Animal Breeders (Columbia, MO) AI organizational

code of <30; other = code of 30 or greater.
[2]S = Sampled in at least 40 herds by a full-service AI organization, M = sampled in at least 40 herds by other AI organizations, and O = other bulls that were not reported as sampled in at least 40 herds by 3 yr of age.

CONCLUSIONS

Holstein bull PTA were stable on average, which indicated that the genetic base is reliable and that no appreciable bias exists even for the extreme bulls (i.e., those in active AI service). Variability with added data is about as expected: a 10% higher SD, which was contributed to by corrections of lactation records and parentage and by minor system changes. Bull PTA tended to decline more for bulls with lower initial REL and larger REL increases. Although those relationships were statistically significant, they were not of practical importance. As expected, SD of PTA change increased with REL change and decreased with initial REL for both the 14,012 AI bulls and the 540 active AI bulls.

Differential usage of active AI bulls was apparent from the larger REL increases for the top bulls for PTA. The average active AI bull had small PTA declines of 8 kg for milk, 1.3 kg for fat, and 0.5 kg for protein, whereas PTA of top decile bulls declined 47, 2.2, and 2.2 kg. The SD of PTA change was much larger than expected for those top bulls and also larger than expected for the bottom bulls. The apparent bias and larger SD for top bulls disappeared when only the bulls with a sampling code of S were included. Although S bulls still had negative correlations between initial PTA and PTA change, those correlations were much smaller than for O bulls, particularly if only younger bulls were considered. Among all active AI bulls, those with a samplinng code of M had correlations similar to those for S bulls; however, for younger bulls, correlations for M bulls were intermediate between those for S and O bulls, which is more pertinent to the assessment of sampling bias.

Mean PTA decreases for M bulls were more similar to those for O bulls than to those for S bulls. Evaluations declined most for bulls that were sampled outside traditional, full-service AI organizations, particularly for younger bulls. Evaluations of bulls that are sampled outside traditional AI organizations (M and O bulls) appear to be positively biased in initial progeny test and to be more variable in future changes. Evaluations of M bulls had intermediate stability, which could cause concern about the combining of S and M codes during 1999. However, bulls that currently have an S code but different sampling and controlling organizations (information that is available in USDA evaluation files and in many evaluation lists) previously would have had a sampling code of M and, therefore, still are identifiable. Bulls with a sampling code of O clearly have early evaluations of lower quality. Because the stability and bias for bulls in active AI service was assessed, positive Mendelian segregation was expected; i.e., DYD and, therefore, PTA were expected to surpass PA. However, the initial DYD for O bulls appears to be positively biased.

Evaluations for active AI bulls overall and especially for S bulls were stable and unbiased. However, problems with stability and bias were detected, particularly for O bulls. Because much of the bias in PTA for those bulls is expected to result from preferential management of early daughters, improvement of industry progeny-test programs or evaluation procedures to eliminate such bias would be difficult.

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